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**WARNING**

Because of possible shock or fire hazards, connection of this instrument should be performed in compliance with the National Electric Code (ANSI C1) or any other requirements, or both, which may be applicable to the user.

Installation, operation, and maintenance should only be performed by qualified personnel.

# TM-111650

## VOLUME 2 -- SERVICE MANUAL

## 626-PA-6018

## IMPULSE ENERGY MONITOR

1 March 1986

See opposite side relative to proprietary rights.

Note: Refer to Volume 1 (Operator's Manual) of TM-111650 for the installation and operation instructions.

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DRANETZ

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# VOLUME II
# SERVICE MANUAL

# 626-PA-6018 IMPULSE ENERGY MONITOR

# SECTION IV
# THEORY OF OPERATION

## 4.1 SCOPE AND INTRODUCTION

Volume 2 of TM-111650 provides the service, calibration, and maintenance instructions for the 626-PA-6018 Impulse Energy Monitor plug-in, referred to as the 6018 plug-in. Volume 2 is divided into four sections: (IV) THEORY OF OPERATION, (V) MAINTENANCE AND CALIBRATION, (VI) REPLACEABLE PARTS LIST, and (VII) SCHEMATICS AND GENERAL ASSEMBLY. (See Volume 1 of TM-111650 for the installation, operation, and operational test instructions for the plug-in: Sections I, II, and III.)

## 4.2 BLOCK DIAGRAM DISCUSSION OF THE ANALOG CIRCUITS

Note: Bold-faced numbers appearing in parentheses refer to the numbered blocks in figure 4-1. The blocks in the figure are numbered at their upper left-hand corners.

### 4.2.1 Voltage Input Signals

The Analog Circuit's voltage input signals are attenuated by a factor of 512 through the broad band attenuator **(1)**. The signals are then applied to the differential amplifier **(2)** which converts them from differential inputs to a single-ended output with a gain of 1.

The variable gain amplifier **(3)** has a gain of 1, 2, or 4, depending on the full scale voltage range selected. An additional input to the amplifier allows for a calibration signal for the SYSTEM CHECK function. The amplifier's output is applied to the absolute value circuit **(4)** and analog multiplier **(8)**.

Pulses of either polarity applied to the absolute value circuit **(4)** are outputted as positive pulses to the peak detector **(5)**. The peak detector captures the peak value and holds it until it is read and reset.

Output of the absolute value circuit **(4)** is also applied to the analog comparator **(7)**. At the analog comparator the output is compared to the user-programmed threshold voltage represented by the output of an 8-bit digital-to-analog convertor **(6)**.

The voltage calibration source **(22)** connects the -8V reference signal **(12)** to a second input on the variable gain amplifier **(3)**, simulating a 500 volt input to the broad band attenuator **(1)** when calibration input signal (J) is low.

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### 4.2.2 Current Input Signal

The current input signal derived from a clamp-on current transformer is applied to the line termination network **(14)** which serves to minimize reflections and spurious inputs. The output of the network is applied to the differential amplifier **(15)**.

Blocks **(15)**, **(16)**, **(17)**, **(18)**, **(19)**, and **(20)** in the current channel perform functions identical to blocks **(2)**, **(3)**, **(4)**, **(5)**, **(6)**, and **(7)** in the voltage channel.

The current calibration source **(21)** connects the -8V reference signal **(12)** to a second input on the variable gain amplifier **(16)**, simulating a 400 amp current pulse in the line monitored by the current probe when calibration signal (J) is low.

### 4.2.3 Analog Multiplier, Analog Comparator, Absolute Value Circuit, & Integrator

The analog multiplier **(8)** multiplies a voltage signal (output of 3) by a current signal (output of 16) to create an output signal which represents instantaneous power. The output of the multiplier is applied to the input of the integrator **(10)**. The integration of power over a period of time produces a signal which represents energy.

The energy signal is applied to the analog comparator **(9)** and absolute value circuit **(11)**. The analog comparator determines the polarity of the energy signal and the absolute value circuit converts all inputs to positive polarity outputs which may read by an analog-to-digital convertor.

The integrator **(13)** integrates a dc input from reference **(12)** to determine pulse duration. Integrating time is controlled by the output of the OR-gate **(14a)** whose output is "true" when either the voltage or current is above the user-programmed threshold [as indicated by the outputs of the two analog comparators: **(7)** and **(20)**].

The block diagram of the analog circuit is illustrated on the following page.

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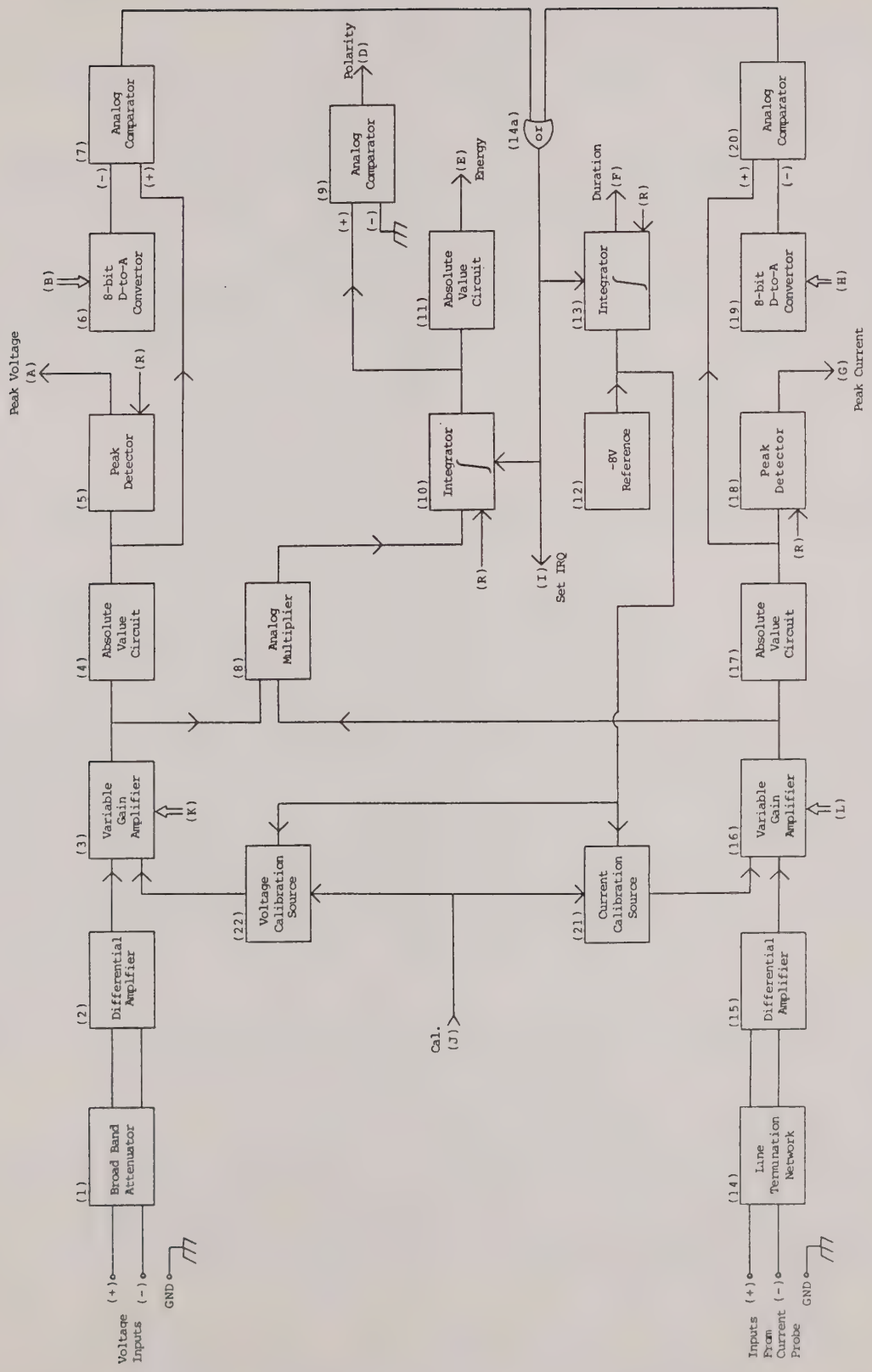


Fig 4-1. Analog Circuit Block Diagram

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## 4.3 BLOCK DIAGRAM DISCUSSION OF THE DIGITAL CIRCUITS

Note: Bold-faced numbers in parentheses refer to the numbered blocks in figure 4-2. The blocks in the figure are numbered at their upper left-hand corners.

Signals representing peak voltage (A), peak current (G), impulse energy (E), and impulse duration (F) are applied to the inputs of the analog multiplexor **(13)**. The signal selected by the multiplexor is then fed through the amplifier **(12)** to the analog-to-digital convertor **(11)**. The amplifier's gain is 1.25.

Outputs of the analog-to-digital convertor are fed through 8- and 2-bit data buses to octal tri-state buffers **(9)** and **(10)**, and from there to a local 8-bit data bus. The local 8-bit data bus communicates to the Series 626 Mainframe's central microprocessor through the input/output (I/O) buffer **(3)** when required.

### 4.3.1 Octal Latches

Information from the Mainframe's microprocessor is communicated to the 6018 plug-in through the I/O buffer **(3)** and then stored in octal latches **(5)**, **(6)**, **(7)**, and **(8)**.

Octal latch **(5)** contains the user-selected voltage threshold. The output of this latch is applied to digital-to-analog convertor [see figure 4-1, block **(6)**, input (B)]. Octal latch **(6)** contains the user-selected current threshold value. The outputs of the latch are applied to the digital-to-analog convertor [see figure 4-1, block **(19)**, input (H)]. Octal latch **(7)** outputs are used to select analog multiplexor **(13)** inputs, reset analog circuits, and clear the interrupt service requests. Octal latch **(8)** outputs select voltage and current input ranges by controlling the gain of the variable gain amplifiers [see figure 4-1, blocks **(3)** and **(16)**, inputs (K) and (L)]. Its outputs also activate calibration signals for the self-test [see figure 4-1, blocks **(21)** and **(22)**, input (J)] and trigger readings of the analog-to-digital convertor **(11)**.

### 4.3.2 Interrupt Control Circuits, Decoder, & Program Memory

Interrupt control circuits **(4)** are activated whenever a user-selected current or voltage threshold has been exceeded, as indicated by the output of the OR-gate [see figure 4-1, OR-gate **(14a)**].

The Decoder **(2)** provides address decoding for Mainframe microprocessor communication with various latches and output buffers.

Program memory **(1)** is used to direct the Mainframe's microprocessor whenever it must interface with the 6018 plug-in. It is connected directly to the Mainframe's data bus, address bus, and board select line.

The digital circuit's block diagram is on the following page.

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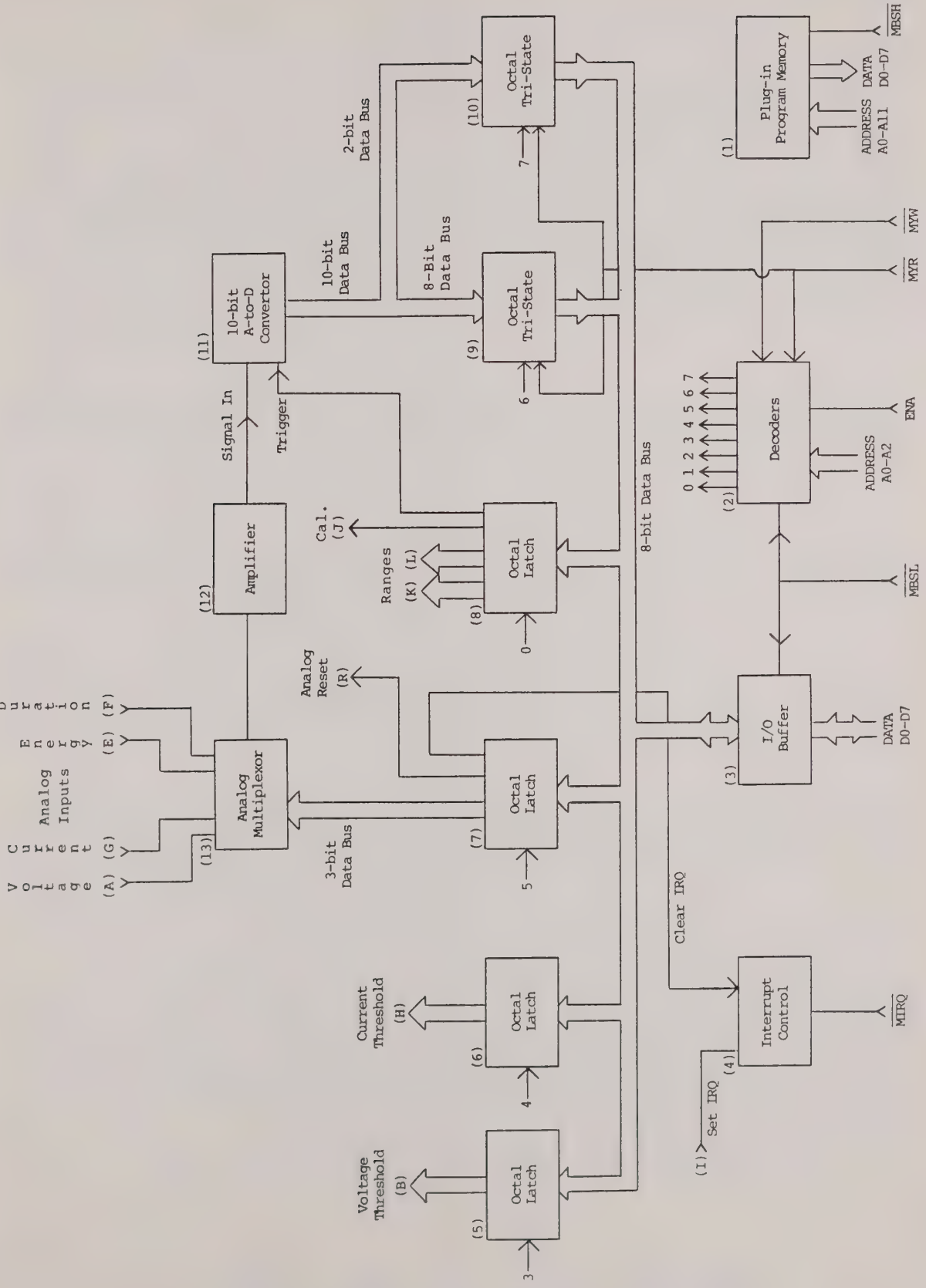


Fig 4-2. Digital Circuit Block Diagram

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## 4.4 DETAILED THEORY OF OPERATION

Note: Refer to figure 7-2 for the schematic diagram of the Impulse Energy board.

### 4.4.1 Voltage Attenuation

The voltage input signal at $E_1$ is applied to a frequency compensated attenuator. R62 and L3 attenuate frequencies above the 6018 plug-in's measurement range. Capacitors C35 and C36 and resistors RN1 and R64 form a 512:1 attenuator. R63 adjusts its frequency response. The voltage input at $E_2$ is similarly attenuated with R66 providing frequency response adjustment.

#### 4.4.1.1 Differential and Variable Gain Amplifiers (Voltage)

Outputs of the attenuators are applied to a differential amplifier consisting of U26 and U25A (pins 5,6,7). R55A adjusts the common mode rejection of this amplifier while R58A adjusts its gain to a value near 1.

Note: These adjustments interact if not done in correct sequence.

The output of the differential amplifier is fed to variable gain amplifier U25A (pins 1,2,3) through analog switch U24A (pins 9, 10,11). Gains of 1, 2, or 4 are selected as follows:

-- For a gain of 4, analog switches U24A (pins 6,7,8) and U24A (pins 14,15,16) are both open.

-- For a gain of 2, switch U24A (pins 14,15,16) is closed.

-- For a gain of 1, both switches are closed. R49A is used to adjust the dc offset of U25A (pins 1,2,3) to zero. R51A, R52A, and C34A provide an alternate input path to U25A which is used to introduce a calibration signal in the self-test mode. Switch U24A (pins 9,10, 11) is opened and switch U24A (pins 1,2,3) is closed to introduce this calibration signal.

#### 4.4.1.2 Absolute Value Circuit

Output of the variable gain amplifier is applied to an absolute value circuit consisting of U22A and U23A. Positive pulses applied to this circuitry propagate through U23A (pins 5,6,7) and U22A. Negative pulses are inverted by U23A (pins 1,2,3) before being applied to U22A. This results in a positive output from U22A (pin 6) regardless of the input polarity.

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#### 4.4.1.3 Two-Stage Peak Detector

Positive pulses are then applied to a 2-stage peak detector consisting of U20A and U21A. U21A through CR3A charges capacitor C30A to the peak value of an input pulse. Since C30A is a small capacitor, it can be charged rapidly in response to a short duration pulse. It is not capable, however, of holding this value until being subsequently digitized. Therefore, the second stage of the peak detector similarly charges C29A to the peak value of the input pulse. Because C29A is a much larger capacitor than C30A, it holds the peak pulse value for the required time. The output of U20A (pin 1), peak voltage, is then applied to analog multiplexor U5 (pin 4).

### 4.4.2 Current Attenuation

The current input signal applied to E3 and E4 is the output of a TR-2019 current probe designed for use with the 6018 plug-in. The scale factor of the voltage which is applied between E3 and E4 is 5 mV/Amp, as determined by the current probe.

L1, L2, R70, R72, C39, and C40 provide low-pass filtering to attenuate input signals beyond the 6018 plug-in's frequency range. Resistors R68, R69, and R71 serve as termination for the cable from the current probe to the plug-in. These terminations reduce reflections and pick-up on the input cable.

#### 4.4.2.1 Differential and Variable Gain Amplifiers (Current)

Signals from the termination network are applied to the inputs of differential amplifier U25B (pins 5,6,7). R55B adjusts common mode rejection and R58B adjusts the gain of this amplifier.

Differential amplifier output U25B (pin 7) is applied to the input of a variable gain amplifier. From this point in the circuit to input pin 5 of multiplexor U5, the current circuits are identical to the voltage circuits previously described.

#### 4.4.2.2 Multiplier

Analog signals representing pulse voltage U25A (pin 1) and current U25B (pin 1) are applied to input pins 1 and 6 of multiplier U31. U31 multiplies voltage times current (V x I) to produce an output voltage at pin 12 which represents instantaneous power. R82 zeroes the output offset of U31 while R85 adjusts its gain.

#### 4.4.2.3 Absolute Value Circuit, Peak Detector, Integrator, Comparator, Multiplexor, & Amplifier

The multiplier output representing power is fed through absolute value circuit U22C and U23C, followed by peak detector U20C and U21C, to pin 6 of multiplier U5.

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The power signal is also fed to integrator U29 through switch U30 (pins 6,7,8 and 9,10,11). Because the integral of instantaneous power over a period of time is energy, the output of U29 (pin 6) is a voltage which represents impulse energy. R81 sets the gain of the integrator. Switch U30 (pins 6,7,8 and 9,10,11) connects the integrator when impulse voltage or current exceeds the user-programmed thresholds and disconnects when the impulse voltage and current both drop below these thresholds. Switch U30 (pin 1,2,3) is used to reset the integrator after its output data has been processed.

The output of U29 (pin 6) is fed through the absolute value circuit, U22D and U23D, to pin 12 of multiplexor U5. The same signal is fed to comparator U4 (pins 10,11,12) which senses its polarity, indicating the direction of energy flow. This directional information from U4 (pin 10) is applied to an input of octal buffer U14 (pin 6) where it may be read by the Mainframe's microprocessor when required.

The same signals which control energy integrator U29 also control duration integrator U28 (pins 5,6,7). This circuit integrates a precision reference voltage created by U28 (pins 1,2,3) and CR9. Since the integral of a dc level is a linear ramp, the output of U28 (pin 7) is proportional to impulse duration. This output is fed to pin 7 of multiplexor U5. Switch U27 (pins 1,2,3 and 14,15,16) connects the reference voltage to the integrator when either voltage or current thresholds are exceeded.

R76 adjusts the reference voltage U28 (pin 1) to the -8.0V dc level required. R74 adjusts the gain of integrator U28 (pins 5,6,7) and R89 adjusts its offset voltage.

Multiplexor U5 selects which of its inputs is to be transferred to its output (pin 8) and applied to the input of amplifier U6. U6 amplifies its input signal by a factor of 1.25 and applies it to analog-to-digital convertor U7 (pin 13).

#### 4.4.2.4 Analog-to-Digital Convertor

When triggered, the analog-to-digital convertor digitizes its input signal and applies the 10-bit result to the local data bus through tri-state buffers U13 and U14. Once information is available on this local bus, it can only be transferred to the Mainframe's data bus via transceiver U17 under control of the Mainframe's microprocessor.

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#### 4.4.2.5 Mainframe-to-Plug-in Communication

The Mainframe's microprocessor communicates with the 6018 plug-in via an 8-bit data bus, 12 address lines, and 7 control lines used for various purposes. These purposes are:

1) $\overline{\text{MBSH}}$ (pin 42) is set "low" to address PROM U19 which contains the software unique to the operation of a 6018 plug-in.

2) $\overline{\text{MBSL}}$ (pin 12) is set "low" to address all hardware located on the 6018 plug-in.

3) R/$\overline{\text{W}}$ (pin 27) is set "high" to read from the 6018 plug-in's hardware and "low" to write to the plug-in's hardware.

4) $\overline{\text{MYW}}$ (pin 26) is set "low" to enable decoder U16 which selects a hardware location to be written to.

5) $\overline{\text{MYR}}$ (pin 56) is set "low" to enable decoder U18 which selects a hardware location to be read.

6) ENA (pin 55) when "high" enables decoders U16 and U18 ONLY when address information is valid.

7) $\overline{\text{MIRQ}}$ (pin 7) is set "low" by the 6018 plug-in to interrupt the Mainframe's microprocessor in order to request service when an event has occurred.

User-set voltage thresholds are communicated to the 6018 plug-in by writing the digital value to latch U9. The 8-bit output of latch U9 is applied to digital-to-analog convertor U1 which, together with amplifier U3 (pins 1,2,3), produces an output voltage proportional to the desired threshold voltage. Comparator U4 (pins 2,3,4) compares this threshold voltage to the voltage output of absolute value circuit U22A (pin 6) to determine if an impulse voltage has exceeded the voltage threshold level.

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Similarly, latch U10, digital-to-analog convertor U2, amplifier U3 (pins 5,6,7), and comparator U4 (pins 14,15,16) determine if an impulse current has exceeded the selected current threshold level.

When either U4 (pins 2,3,4) or U4 (pins 14,15,16) signal that a threshold has been exceeded, U4 (pins 6,7,8), acting as a NOR-gate, produces a "low" output which sets IRQ latch U8 (pins 1,2,3 and 4,5,6), triggering 1-shot U15 (pins 1,4). When this 1-shot times-out, the $\overline{\text{MIRQ}}$ line is brought "low" through NAND-gate U8 (pins 8,9,10), signaling the Mainframe's microprocessor that an event has taken place and should be processed.

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# SECTION V
# MAINTENANCE AND CALIBRATION

## 5.1 GENERAL

This section contains the maintenance and calibration instructions for the 6018 plug-in. The only required maintenance for the 6018 plug-in is its calibration, which should be done every 12 months. You may return the plug-in to the factory for calibration after contacting Dranetz Service Corp. for instructions (Tel. No. 201-287-2535, TWX: 710-997-9553, Telex: 499-7808, Cable: DRANETZ), or, you may calibrate the plug-in on your own with proper equipment by following the section's instructions.

### 5.1.1 Maintenance

Read over the entire Maintenance section of TM-111650U, Volume 2 (Series 626 Mainframe manual) before proceeding further.

### 5.1.2 Service Warning

**WARNING**

The following calibration instructions are intended for qualified personnel ONLY. To avoid electrical shock, DO NOT perform any service other than that contained in your Operator's manual unless you are qualified.

DO NOT attempt internal service or adjustment unless another person, capable of rendering aid and resuscitation, is present.

Read Instructions Carefully

Because of possible shock or fire hazard, DO NOT perform any service tasks beyond your qualifications. Your qualifications for performing such tasks should be self-determined.

## 5.2 CALIBRATION PROCEDURE

### 5.2.1 Plug-in Removal

**WARNING**

Be sure that the Series 626 Mainframe and all power connected to its modules is turned off.

1) Loosen the plug-in's top and bottom captive screws.

2) Carefully slide the plug-in out of the Mainframe.

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### 5.2.2 Required Test Equipment

1) Series 626 Mainframe.

2) Extender Card: P/N 110260 (or equal).

3) Calibrated oscilloscope with wave form cursors, digital display, ±2% accuracy, and a minimum band width of 25 MHz.

   Recommended: Tektronix model 2445.

4) 450V dc low current power supply.

   Recommended: Acopian 475 UA02 (or equal).

5) Direct current voltmeter, ±1% accuracy, 0.1 mV resolution on most sensitive range, capable of reading at least 320 V dc on highest range.

   Recommended: Fluke model 73.

6) Test impulse generating circuit (configured to figure 5-1 specifications).

7) 50uS, 10V impulse source.

   Recommended: Wavetek model 162 (or similar).

### 5.2.3 Extender Card Installation

1) Slide the extender card into the 6018 plug-in's slot until firmly in place.

   Note: If the lettering on the extender card is upside down, the card is upside down, therefore, flip it over before inserting.

2) Attach the 6018 plug-in to the end of the extender card and tighten its captive screws. Using a clipped lead, connect the plug-in's rear panel to the metal chassis of the Mainframe.

   Note: Brace the bottom of the plug-in so that weight of the test equipment does not pull it out of place.

3) Turn on the Series 626 Mainframe.

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### 5.2.4 Test Impulse Generating Circuit Configuration

The test impulse generating circuit is configured according to figure 5-1.

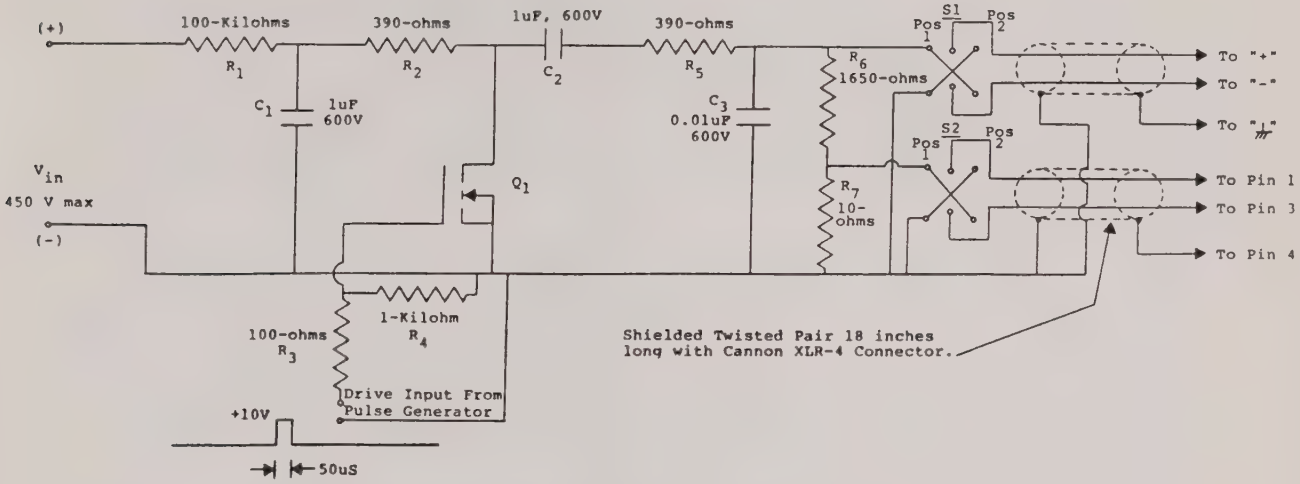


Figure 5-1. Test Impulse Generating Circuit

### 5.2.4.1 Reference Key to Figure 5-1

| Ref. | Description |
|---|---|
| $Q_1$ | N Channel 500V, 3A, F.E.T. International Rectifier (IRF 830) |
| $C_1$, $C_2$ | 1.0uF±20%, 600V, Film Cap. CDE MMW6W1 |
| $R_1$ | 100-Kilohms±5%, 2W, Carbon Res. |
| $R_2$, $R_5$ | 390-ohms±5%, 2W, Carbon Res. |
| $R_6$ | 1650-ohms±0.5%, 0.5W, Film Res. |
| $R_7$ | 10-ohms±0.5%, 0.25W, Film Res. |
| $C_3$ | 0.01uF±20%, 600V, Film Cap. CDE MMW6S1 |
| $R_3$ | 100-ohms±5%, 0.25W, Carbon Res. |
| $R_4$ | 1-Kilohm±5%, 0.25W, Carbon Res. |
| $S_1$, $S_2$ | D.P.D.T. Toggle Switch C&K #7201 |

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### 5.2.5 Offset Voltage Adjustments

1) Use the dc voltmeter to adjust the following potentiometers (pots) for 0±0.005 volts with respect to circuit ground ("+" side of C24) at the points listed:

| Test Point | Adjustment Potentiometer |
|---|---|
| U25A, Pin 1 | R49A |
| U25B, Pin 1 | R49B |
| U31, Pin 1 | R82 |
| U20C, Pin 1 | R87 |
| U28, Pin 7 | R89 |

### 5.2.6 Reference Voltage Adjustment

1) Use the dc voltmeter to adjust R76 for -8.0±0.1 volts at U28, pin 1.

### 5.2.7 Frequency Compensation of Voltage Attenuators

1) Using the circuit of figure 5-1 and the dc power supply, apply a -300 volt impulse to the "+" voltage input terminal with respect to the ground terminal.

2) Observe and record the impulse amplitude at U26, pin 7 using an oscilloscope.

3) Remove the impulse source and apply -300 volts dc to the same terminals using the dc power supply.

4) Adjust R63 so the voltage at U26, pin 7 is the same level as observed with the impulse input (step 2).

5) Repeat steps 1 through 4 using inputs applied to the "-" terminal instead of the "+" terminal, and outputs read at U26, pin 1 instead of inputs at U26, pin 7.

6) Adjust R66 accordingly.

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### 5.2.8 Voltage Gain and CMMR Setting

1) Connect all voltage and current terminals to the test impulse generating circuit as illustrated in figure 5-1.

2) Program the following: 1000 volts F.S.,
500 amps F.S.,
100 volt threshold,
100 amp threshold.

3) Using the test impulse generating circuit, apply a -300 volt impulse between the "-" input voltage input terminal (S1, Pos 2) and ground.

4) Adjust R58A for a printout of 300 volts by the Series 626 Mainframe.

5) Apply a -300 volt impulse between the "+" input voltage terminal and ground (S1, Pos 1).

6) Adjust R55A for a printout of 300 volts by the Series 626 Mainframe.

### 5.2.9 Current Gain and CMMR Setting

1) Apply a -1.5 volt impulse between pin 3 of the current probe connector and ground (S2, Pos 2).

2) Adjust R58B for a printout of 300 amps by the Series 626 Mainframe.

3) Apply a -1.5 volt impulse between Pin 1 of the current probe connector ground (S2, Pos 1).

4) Adjust R55B for a printout of 300 amps by the Series 626 Mainframe.

### 5.2.10 Duration Gain Setting

1) Apply a -300 volt impulse between the "+" voltage input terminal and ground (S1, Pos 1).

2) Using the oscilloscope's cursors and digital display capability, record the time that the impulse voltage remains above the 100-volt level.

3) Adjust R74 for a duration printout identical to the one of step 2.

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### 5.2.11 Energy Gain Setting

1) Apply a -300 volt impulse between the "+" voltage input terminal and ground (S1, Pos 1).

2) Using the oscilloscope's cursors and digital display capability, record the time that the impulse voltage remains above the 100-volt level.

3) Calculate the impulse energy in Joules as follows:

$$E = K_1 V^2 \text{ Delta(t) Joules}$$

where: $K_1$ is 0.87 for the impulse wave shape generated by the source of figure 5-1.

V is the impulse peak voltage of 300 volts.

Delta(t) is the time that the impulse voltage exceeds 100 volts (as measured in step 2).

4) Center R85.

5) Adjust R81 for an energy printout as calculated.

6) If R81 has insufficient range, adjust R85 as well.

### 5.2.12 System Check Calibration

1) Program the plug-in's "PRESET" conditions (refer to the Operator's manual).

2) With no input signals active, request a "SYSTEM CHECK."

3) Adjust R53A for a printout of 500 volts ±1%.

4) Adjust R53B for a printout of 400 amps ±1%.

### 5.2.13 Finishing Up

1) Remove all test equipment from the plug-in.

2) Turn off the Series 626.

3) Remove the plug-in from the extender card, and then the extender card itself.

4) Carefully reinsert the plug-in and tighten its two captive screws.

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# SECTION VI
# REPLACEABLE PARTS LIST

## 6.1 GENERAL

The replaceable parts are listed in table 6-1 which begins on the following page. Contained in the parts list is each part's description, identification number, reference designation, and manufacturer's code. Much of the replaceable hardware was omitted from this table. For further information on the replaceable hardware, contact Dranetz Service Corporation.

### 6.1.1 Reference Designations

Refer to figure 7-1 in section VII for assembly drawing reference designations of the replaceable parts.

Note: Replaceable parts listed in Table 6-1 are extracted from LM111660.

## 6.2 Manufacturer's Reference Codes

The manufacturer's reference code from Table 6-1 is:

| Man. Code | Source |
|---|---|
| 23207 | Dranetz Technologies, Inc.<br>1000 New Durham Rd., PO Box 4019<br>Edison, New Jersey 08818-4019<br>(201) 287-3680 |
| 81349 | On MIL Specifications list.<br>Manufactured to meet military specifications. Available from a variety of suppliers. |

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Table 6-1. Replaceable Parts List (Page 1 of 6)

| REFERENCE DESIGNATION | PART OR IDENT. # | MAN. CODE | DESCRIPTION |
|---|---|---|---|
| C1,C2,C4, C5,C12,C17, C18,C21,C23, C25,C26,C42, C44-C59 | 103209-G2 | 23207 | Cap Fxd Cer, 0.22uF±20%, 50V |
| C3,C6,C29A-C | 104092-G1 | 23207 | Cap Fxd Met-Poly, 0.01±10%, 50V |
| C8,C10,C13, C14 | 104027-G2 | 23207 | Cap Fxd Cer, 10pF±5%, 500V |
| C16,C33A-D | 104022-G3 | 23207 | Cap Fxd Mica, 56pF±5%, 100V |
| C19 | 104006-G1 | 23207 | Cap Fxd Tant, 1uF±10%, 50V |
| C20 | 104018-G2 | 23207 | Cap Fxd Mica, 47pF±5%, 500V |
| C22,C24 | 104067-G4 | 23207 | Cap Fxd Tant, 15uF±10%, 16V |
| C27 | 104067-G3 | 23207 | Cap Fxd Tant, 56uF±10%, 6V |
| C28A-C,C32D | 104018-G5 | 23207 | Cap Fxd Mica, 150pF±5%, 500V |
| C30A-C,C34A | 104011-G1 | 23207 | Cap Fxd Mica, 100pF±5%, 100V |
| C31A-C | 104018-G4 | 23207 | Cap Fxd Mica, 120pF±5%, 500V |
| C32A-C | 104020-G1 | 23207 | Cap Fxd Mica, 470pF±5%, 100V |
| C34B | 104022-G4 | 23207 | Cap Fxd Mica, 200pF±5%, 500V |
| C35,C38 | 104093-G1 | 23207 | Cap Fxd Mica, 43pF±5%, 1000V |
| C36,C37,C41 | 104092-G3 | 23207 | Cap Fxd Met-Poly, 0.022±5%, 50V |

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Table 6-1. Replaceable Parts List (Page 2 of 6)

| REFERENCE DESIGNATION | PART OR IDENT. # | MAN. CODE | DESCRIPTION |
|---|---|---|---|
| C39,C40 | 104021-G1 | 23207 | Cap Fxd Mica, 1000pF±5%, 100V |
| C43 | 104092-G2 | 23207 | Cap Fxd Met-Polv, 0.01uF±5%, 50V |
| CR1A-B,CR2A-B, CR3A-C,CR4A-C, CR5A-D,CR6A-D, CR7A-D,CR8A-D | 104412-G2 | 23207 | Diode |
| CR1C,CR2C | 102899 | 23207 | Diode |
| CR9 | 103295 | 23207 | Diode, Zener |
| Q1A-C,Q2A-C | 104515 | 23207 | Transistor |
| L1,L2 | 103580-G1 | 23207 | Ferrite Bead |
| L3,L4 | 103580-G4 | 23207 | Ferrite Bead |
| R1,R2,R4,R5 | RN55C4021F | 81349 | Res Fxd Flm, 4.02K±1%, 1/10W |
| R3,R6 | RN55C2051F | 81349 | Res Fxd Flm, 2.05K±1%, 1/10W |
| R7,R8,R11, R12,R19,R20 | RCR07G362J | 81349 | Res Fxd Comp, 3.6K±5%, ¼W |
| R9,R13 | RCR07G624J | 81349 | Res Fxd Comp, 620K±5%, ¼W |
| R10,R14 | RCR07G392J | 81349 | Res Fxd Comp, 3.9K±5%, ¼W |
| R15 | RCR07G332J | 81349 | Res Fxd Comp, 3.3K±5%, ¼W |
| R16 | RCR07G363J | 81349 | Res Fxd Comp, 36K±5%, ¼W |
| R17 | RCR07G564J | 81349 | Res Fxd Comp, 560K±5%, ¼W |
| R18 | RCR07G105J | 81349 | Res Fxd Comp, 1M±5%, ¼W |
| R21,R22,R24, R44A-D,R79 | RCR07G103J | 81349 | Res Fxd Comp, 10K±5%, ¼W |

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Table 6-1. Replaceable Parts List (Page 3 of 6)

| REFERENCE DESIGNATION | PART OR IDENT. # | MAN. CODE | DESCRIPTION |
|---|---|---|---|
| R23 | RCR07G223J | 81349 | Res Fxd Comp, 22K±5%, ¼W |
| R25 | RCR07G203J | 81349 | Res Fxd Comp, 20K±5%, ¼W |
| R26 | RN55C4991F | 81349 | Res Fxd Flm, 4.99K±1%, 1/10W |
| R27 | RN55C1241F | 81349 | Res Fxd Flm, 1.24K±1%, 1/10W |
| R28 | RN55C1130F | 81349 | Res Fxd Flm, 113±1%, 1/10W |
| R29A-C, R38A-C, R41A-D | RCR07G222J | 81349 | Res Fxd Comp, 2.2K±5%, ¼W |
| R30A-C, R39A-C | RCR07G331J | 81349 | Res Fxd Comp, 330±5%, ¼W |
| R31A-C | RCR07G911J | 81349 | Res Fxd Comp, 910±5%, ¼W |
| R32A-C, R33A-C, R37A-C | RCR07G107J | 81349 | Res Fxd Comp, 100M±5%, ¼W |
| R34A-C, R35A-C | RCR07G512J | 81349 | Res Fxd Comp, 5.1K±5%, ¼W |
| R36A-C | RCR07G821J | 81349 | Res Fxd Comp, 820±5%, ¼W |
| R40A-D | RCR07G472J | 81349 | Res Fxd Comp, 4.7K±5%, ¼W |
| R42A-D, R43A-D | RN55C4321F | 81349 | Res Fxd Flm, 4.32K±1%, 1/10W |
| R45A,R45B | RN55E1002B | 81349 | Res Fxd Flm, 10K±0.1%, 1/10W |
| R46A,R46B, R47A,R47B | RN55E2002B | 81349 | Res Fxd Flm, 20K±0.1%, 1/10W |
| R48A,R48B | RCR07G125J | 81349 | Res Fxd Comp, 1.2M±5%, ¼W |

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Table 6-1. Replaceable Parts List (Page 4 of 6)

| REFERENCE DESIGNATION | PART OR IDENT. # | MAN. CODE | DESCRIPTION |
|---|---|---|---|
| R49A,R49B, R82,R87 | 104701-G8 | 23207 | Res Var, 50K±10%, ½W |
| R50A,R50B | RN55C4991F | 81349 | Res Fxd Flm, 4.99K±1%, 1/10W |
| R51A | RN55C2002F | 81349 | Res Fxd Flm, 20K±1%, 1/10W |
| R51B,R86 | RN551002F | 81349 | Res Fxd Flm, 10K±1%, 1/10W |
| R52A | RN55C1502F | 81349 | Res Fxd Flm, 15K±1%, 1/10W |
| R52B | RN55C1242F | 81349 | Res Fxd Flm, 12.4K±1%, 1/10W |
| R53A,R74 | 104700-G4 | 23207 | Res Var, 10K±10%, ½W |
| R53B | 104701-G7 | 23207 | Res Var, 5K±10%, ½W |
| R54A,R56A | RN55C4871F | 81349 | Res Fxd Flm, 4.87K±1%, 1/10W |
| R54B,R56B, R57B,R59B, R80 | RN55C9091F | 81349 | Res Fxd Flm, 9.09K±1%, 1/10W |
| R55A | 104700-G3 | 23207 | Res Var, 1K±10%, ½W |
| R55B,R58B, R76,R81,R85 | 104701-G1 | 23207 | Res Var, 2K±10%, ½W |
| R57A,R59A | RN55C5111F | 81349 | Res Fxd Flm, 5.11K±1%, 1/10W |
| R58A | 104701-G6 | 23207 | Res Var, 500±10%, ½W |
| R60,R61 | RCR07G102J | 81349 | Res Fxd Comp, 1K±5%, ¼W |
| R62,R67 | RN60C1002F | 81349 | Res Fxd Flm, 10K±1%, 1/8W |
| R63,R66 | 104719-G3 | 23207 | Res Fxd Flm, 10K±10%, ½W |

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Table 6-1. Replaceable Parts List (Page 5 of 6)

| REFERENCE DESIGNATION | PART OR IDENT. # | MAN. CODE | DESCRIPTION |
|---|---|---|---|
| R64,R65 | RN55C7502F | 81349 | Res Fxd Flm, 75K±1%, 1/10W |
| R68,R69 | RN55C8060F | 81349 | Res Fxd Flm, 806±1%, 1/10W |
| R70,R72 | RN55C2000F | 81349 | Res Fxd Flm, 200±1%, 1/10W |
| R71 | RCR07G510J | 81349 | Res Fxd Comp, 51±5%, ¼W |
| R73 | RN55C3572F | 81349 | Res Fxd Flm, 35.7K±1%, 1/10W |
| R75 | RN55C3011F | 81349 | Res Fxd Flm, 3.01K±1%, 1/10W |
| R77 | RN55C1102F | 81349 | Res Fxd Flm, 11K±1%, 1/10W |
| R78 | RN55C6191F | 81349 | Res Fxd Flm, 6.19K±1%, 1/10W |
| R83,R88 | RCR07G204J | 81349 | Res Fxd Comp, 200K±5%, 1/10W |
| R84 | RN55C2001F | 81349 | Res Fxd Flm, 2K±1%, 1/10W |
| R89 | 104700-G5 | 23207 | Res Var, 100K±10%, ½W |
| R90 | RN55C1003F | 81349 | Res Fxd Flm, 100K±1%, 1/10W |
| R91 | RN55C1000F | 81349 | Res Fxd Flm, 100-ohms±1%, 1/10W |
| RN1,RN2 | 104711 | 23207 | Res Network, 40M, 301K |
| U1,U2 | 104287-G1 | 23207 | I.C., D-to-A Convertor |
| U3,U20A-C, U21A-C,U23A-D, U25A-B,U26, U28 | 104228 | 23207 | I.C., Dual Op-Amp |

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Table 6-1. Replaceable Parts List (Page 6 of 6)

| REFERENCE DESIGNATION | PART OR IDENT. # | MAN. CODE | DESCRIPTION |
|---|---|---|---|
| U4 | 104241-G2 | 23207 | I.C., Quad Comparator |
| U5 | 104286-G1 | 23207 | I.C., 1 of 8 MUX |
| U6 | 104224-G3 | 23207 | I.C. Op-Amp |
| U7 | 104365 | 23207 | I.C. 10-Bit A-to-D |
| U8 | 104214-G6 | 23207 | I.C., Quad NAND |
| U9-12 | 104290-G4 | 23207 | I.C., Octal "D" Flip-Flop |
| U13,U14 | 104290-G5 | 23207 | I.C. Octal Buffer |
| U15 | 104216-G5 | 23207 | I.C., Dual 1-Shot |
| U16,U18 | 104290-G2 | 23207 | I.C., 3-to-8 Decoder |
| U17 | 104290-G3 | 23207 | I.C., Octal Transceiver |
| U19 | See PROM Program Listing 105909 | 23207 | I.C. PROM |
| U22A-D,U29 | 104251-G1 | 23207 | I.C. Op-Amp |
| U24A,U24B, U27,U30 | 104362 | 23207 | I.C. Quad Switch |
| U31 | 104288-G1 | 23207 | I.C. Multiplier |
| Used @ U31 | 110749-G2 | 23207 | I.C. Socket, 14-pin |
| Used @ U7 | 110749-G4 | 23207 | I.C. Socket, 18-pin |
| Used @ U19 | 110749-G7 | 23207 | I.C. Socket, 24-pin |

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# SECTION VII
# SCHEMATICS AND GENERAL ASSEMBLY

## 7.1 GENERAL

This section of the manual contains the schematic diagram and assembly drawing for the 6018 plug-in. The revision levels of the schematic and assembly are indicated on their respective pages.

## 7.2 ASSEMBLY DRAWING

Illustrated on fold-out page 7-3/7-4 is the assembly drawing of the Impulse Energy Board (6018 plug-in): Assy 111660.

## 7.3 SCHEMATIC DIAGRAM

Illustrated on fold-out page 7-5/7-6 is the schematic of the Impulse Energy Board (6018 plug-in): Assy 111660, Schem 111665.

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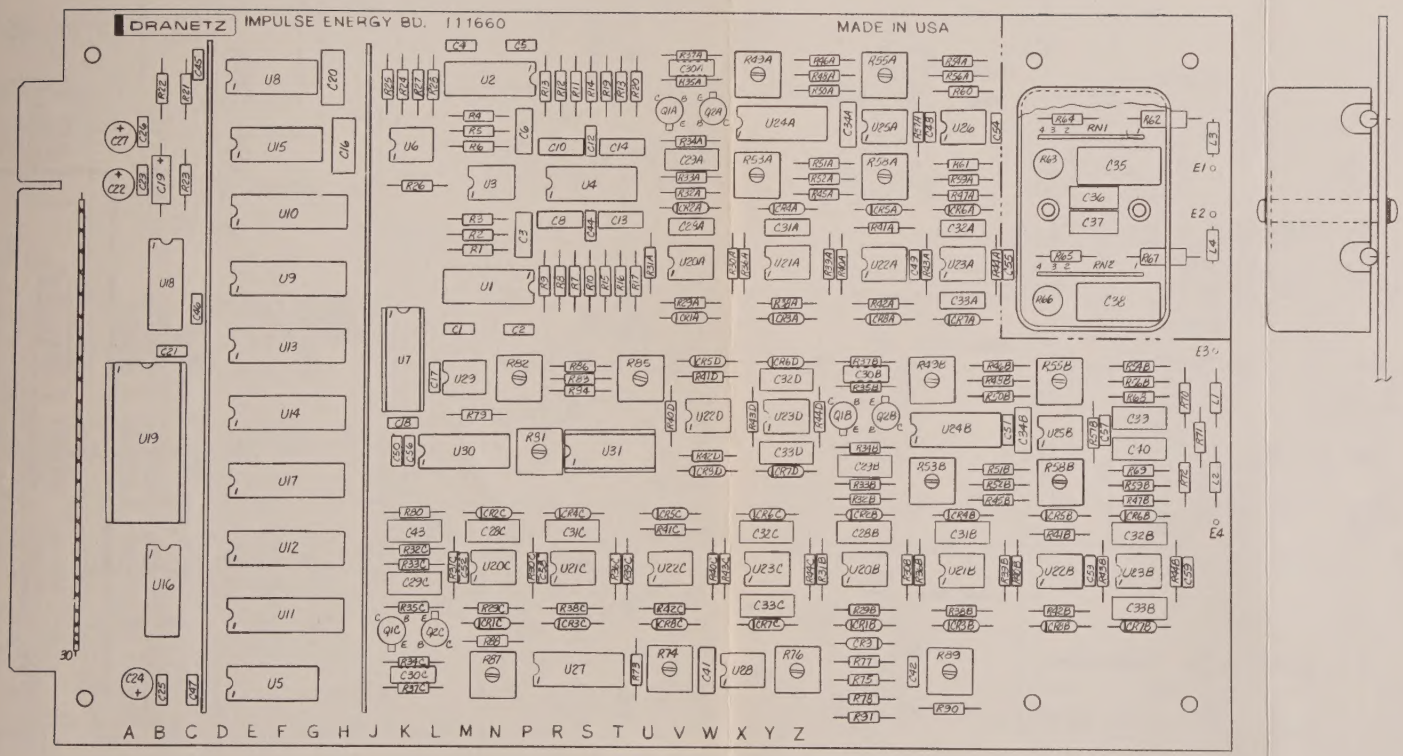


COMPONENT SIDE

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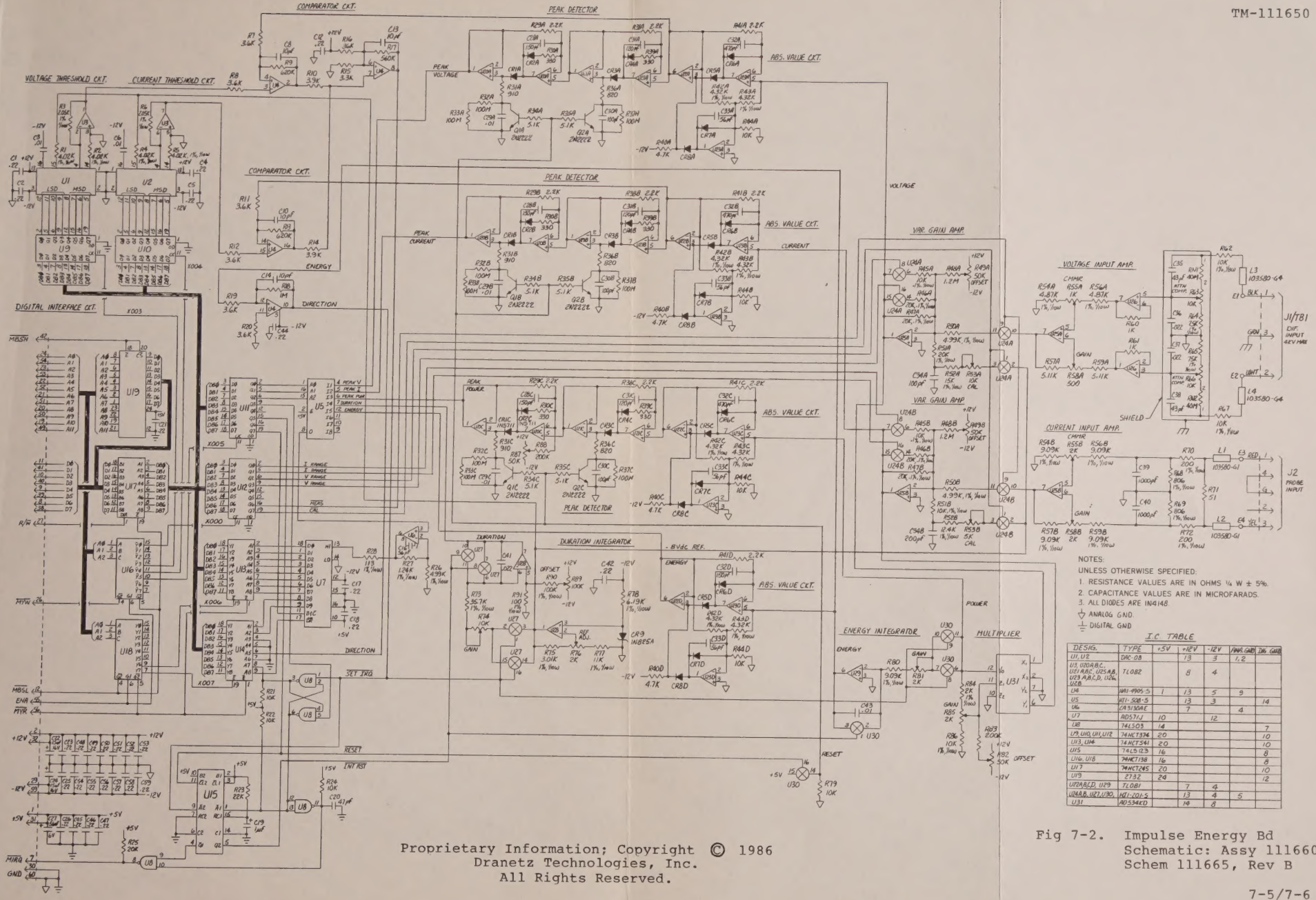
Fig 7-1. Impulse Energy Bd
Assy: 111660, Rev B




NOTES:
UNLESS OTHERWISE SPECIFIED:
1. RESISTANCE VALUES ARE IN OHMS ¼ W ± 5%.
2. CAPACITANCE VALUES ARE IN MICROFARADS.
3. ALL DIODES ARE IN4148.
⏚ ANALOG GND.
⏚ DIGITAL GND

I.C. TABLE

| DESIG. | TYPE | +5V | +12V | -12V | ANA. GND | DIG GND |
|---|---|---|---|---|---|---|
| U1, U2 | DAC-08 | | 13 | 3 | 1,2 | |
| U3, U20A,B,C, U21A,B,C, U23A,B,C,D, U24A, U28 | TL082 | | 8 | 4 | | |
| U4 | MAI-6905-5 | 1 | 13 | 5 | 9 | |
| U5 | MAI-5281-5 | | 13 | 3 | | 14 |
| U6 | CA3130AE | | 7 | | 4 | |
| U7 | AD571J | 10 | | 12 | | |
| U8 | 74LS03 | 14 | | | | 7 |
| U9, U10, U11, U12 | 74HCT374 | 20 | | | | 10 |
| U13, U14 | 74HCT541 | 20 | | | | 10 |
| U15 | 74LS123 | 16 | | | | 8 |
| U16, U18 | 74HCT138 | 16 | | | | 8 |
| U17 | 74HCT245 | 20 | | | | 10 |
| U19 | 2732 | 24 | | | | 12 |
| U22A,B,C,D, U29 | TL084 | | 7 | 4 | | |
| U24A,B, U27, U30, | MAI-201-5 | | 13 | 4 | 5 | |
| U31 | AD534CD | | 14 | 8 | | |

Fig 7-2. Impulse Energy Bd Schematic: Assy 111660, Schem 111665, Rev B

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